Schoolyard Cleanups

This document replicates the content found at http://www.coastal.ca.gov/publiced/schoolyard/, where you can register to participate in the Schoolyard Cleanup program. If you are unable to access the internet for the links embedded within this document, or have other questions, please contact Annie Kohut Frankel, California Coastal Commission Public Education Program, (415) 587-5888, Annie.Frankel@coastal.ca.gov.

Want your students to participate in California Coastal Cleanup Day, http://www.coastal.ca.gov/publiced/ccd/ccd.html, (the third Saturday in September) but can't get them out on a field trip to a beach or local waterway? Want to show them that environmentally responsible behavior can begin at their school and in their own neighborhood? Interested in a real world data collection and problem-solving experience that takes place right on school grounds and supports your Next Generation Science Standards? You can organize a Schoolyard Cleanup and accomplish all of these goals. Register your school as a Schoolyard Cleanup Site to receive assistance and recognition and to be a part of an international effort to protect our coast and ocean, no matter where your school is!

Pre-Cleanup

We've endeavored to provide you everything you need to hold a cleanup, from preparatory lessons through cleanup materials, to data analysis. Participating schools are NOT required to do pre- and post-lessons, but these can help illuminate the impact of a cleanup and tie it into your education standards.

Just like water, trash can move through a watershed, down streets, through storm drains, creeks and rivers, and eventually out to a lake or the ocean. Preventing and removing litter in school yards and neighborhoods is stopping marine debris before it happens! You may not have the sound of the surf in your ears, but you are taking very important action to protect our coast and ocean and the creatures that depend on a healthy ecosystem to survive.

What is a watershed?
- "Branching Out" (http://www.coastal.ca.gov/publiced/waves/waves_5.pdf#page=14) from the California Coastal Commission's *Waves, Wetlands, and Watersheds*, http://www.coastal.ca.gov/publiced/waves/waves1.html (*NGSS and CCSS connections at http://www.coastal.ca.gov/publiced/schoolyard/branching_out_ngss.html*)
- "Watershed in Your Hands" from Save The Bay, http://www.savesfbay.org/sites/default/files/WATERSHED_IN_YOUR_HANDS.PDF
- "Determining a watershed from a topographic map," USDA Natural Resources Conservation

Service, http://www.nycswcd.net/files/NRCS%20Reading%20Topo%20Maps%20to%20Delineate%20Watersheds1.pdf
- "How to Delineate Watershed Boundaries," URI Cooperative Extension, presentation, http://www.uri.edu/smile/documents/MapreadingTOPO_SMILE_071812Final.pdf

Marine debris and nonpoint source pollution:
- Read about the Problem with Marine Debris on our website, http://www.coastal.ca.gov/publiced/marinedebris.html.
- "Searching Out Nonpoint Sources of Pollution," http://www.coastal.ca.gov/publiced/waves/waves_9_6.pdf, from the California Coastal Commission's *Waves, Wetlands, and Watersheds*, http://www.coastal.ca.gov/publiced/waves/waves1.html (*NGSS and CCSS connections at http://www.coastal.ca.gov/publiced/schoolyard/searching_out_npsp_ngss.html*)
- "You Are What You Eat: Plastics and Marine Life," http://www.coastal.ca.gov/publiced/waves/waves_8.pdf#page=8, from the California Coastal Commission's *Waves, Wetlands, and Watersheds*, http://www.coastal.ca.gov/publiced/waves/waves1.html (*NGSS and CCSS connections at http://www.coastal.ca.gov/publiced/schoolyard/you_are_what_you_eat_ngss.html*)

Recommended books for classroom read-aloud:
- *This is the Ocean*, by Kersten Hamilton, Illustrated by Lorianne Siomades
- *All the Way to the Ocean*, by Joel Harper

Videos:
- *The Adopt-A-Beach School Assembly Program* - 21 minutes, grades 3 and up. The Malibu Foundation for Environmental Education produced this DVD, which includes excerpts from a live assembly program for students about the sources and impacts of marine debris. 2009. DVD free by request at http://www.coastal.ca.gov/publiced/directory/educate.html#library.
- *Saving Inky* - 20:25 min. running time. A video for all ages about a pygmy sperm whale that ingested plastics from the ocean, was treated at the Baltimore Aquarium and then set free. 1994. DVD available free from our lending library at http://www.coastal.ca.gov/publiced/directory/educate.html#library or video available for viewing online in three parts at https://www.youtube.com/watch?v=tZJ29-Kkovw&list=PL718D542A7EB60E93&index=1.
- *The Trash Troll* - 12:30 min. running time, for grades K-5. Teaches children the impacts of beach trash on marine animals. 1993. DVD available free from our lending library at http://www.coastal.ca.gov/publiced/directory/educate.html#library.
- *Synthetic Sea: Plastics in the Ocean* - 9 min. approximate running time, grades 7 and up. An alarming look at the role plastics is playing in our waters, specifically

the Pacific Ocean, by Algalita Marine Research Institute. DVD available free from our lending library at http://www.coastal.ca.gov/publiced/directory/educate.html#library or online at http://www.algalita.org/movs/pelagic_plastic_mov.html. 2001.

- *Gyre: Creating Art From a Plastic Ocean* - 20:14 minutes. Grades 7 and up. National Geographic program shows an artists' expedition to Alaska with the goal to make art from the trash found on the beaches. Online at https://www.youtube.com/watch?v=cr5m8b28eqA&feature=youtu.be.
- *Ocean Heroes: The Plastics Problem* - 5 Gyres Institute - 2:17 minutes. Grades 9 and up. One World One Ocean interview with Anna Cummins and Marcus Erickson about plastic pollution in the ocean. Online at https://www.youtube.com/watch?v=8BL5o7nRKtE.
- *Marine Debris* - 3:17 minutes. All ages. An explanation of the marine debris problem by NOAA National Ocean Service. Online at https://www.youtube.com/watch?v=xmnz-8p0AB0.
- *Our Debris Filling the Sea* - 2:36 minutes. Grades 4 and up. NOAA presents the marine debris problem. Streaming, downloadable and captioned at http://oceantoday.noaa.gov/ourdebrisfillingthesea/.
- *Trash in the Deep Sea: Bringing a Hidden Problem to Light* - 4:12 minutes. Grades 4 and up. Describes Monterey Bay Aquarium Research Institute's research into debris in the deep ocean. Online at https://www.youtube.com/watch?v=mOZngsJU2k0.
- *The Majestic Plastic Bag* - 3:59 minutes. Grades 4 and up. Mock "wildlife" documentary about the plastic bag, from Heal the Bay. Online at https://www.youtube.com/watch?v=GLgh9h2ePYw.
- *Ocean Trash is a Problem You Can Solve* - 1:29 minutes. All ages. Statistics from International Coastal Cleanup Day from the Ocean Conservancy. Online at https://www.youtube.com/watch?v=aW_qq37wOoA.
- *International Coastal Cleanup Data Release 2013* - 1:50 minutes. Grades 4 and up. Statistics in captions (must be able to read fairly quickly), infogram-style. From the Ocean Conservancy. Online at https://www.youtube.com/watch?v=g0Fg1fYnVis.
- Midway Journey short films on YouTube at https://www.youtube.com/user/journeytomidway/videos. Impacts of plastic trash on Midway Island and the island's nesting Laysan Albatross. Some recommended titles:
  - *Plastic Beach* - 2:25 minutes. The seemingly endless deposition of plastic debris onto a single beach on Midway Island. All ages, however this does not present any solutions, just the problem. https://www.youtube.com/watch?v=HN9j0y9bivo
  - *Bottle Caps* - 4:18 minutes. Grades 4 and up. Examining the carcass of a Laysan albatross, and the plastic contents of its stomach, with the Deputy Wildlife Manager of Midway Atoll National Wildlife Refuge. https://www.youtube.com/watch?v=8Ri0RAsctYo
  - *Junk Food III - Looking in the Mirror* - 3:13 minutes. Grades 4 and up. A very up-close, emotional examination of a Laysan albatross carcass, with

reflection on the connection to human health. https://www.youtube.com/watch?v=sszT-joZoz8

Infographic
"The Ugly Journey of Our Trash" by Project AWARE
http://www.projectaware.org/sites/default/files/TheUglyJourneyofTrashInfographic_PDF.pdf

Slideshow
A few slides about marine debris and where it comes from (PowerPoint)
http://www.coastal.ca.gov/publiced/schoolyard/marinedebris.ppt

Doing Your Cleanup

What You Need:
- The Coastal Commission can provide registered groups with disposable trash and recycle bags and plastic gloves. If feasible, please try to reduce the waste from your cleanup with the following strategies:
  - Ask students to bring gardening or work gloves from home to use during the cleanup. If cleanups will be an ongoing activity at your school, consider raising money or asking your PTA to purchase a class set, or requesting a donation from a local hardware or garden supply store.
  - Use buckets or reusable bags for collecting trash. The cafeteria may have buckets that can be repurposed for a cleanup. You may also be able to use the small plastic trash bins from the classrooms, as long as you carefully return them after the cleanup. Other possible trash containers include: reused shopping bags, an opened half-gallon milk carton, a cardboard oatmeal cylinder, a plastic milk jug or 2-liter bottle with the top cut off.
- Data cards, either printed out by you (in English or Spanish) or request them from the Coastal Commission when you register
- Pencils for collecting data
- A bathroom scale for weighing your trash
- Access to dumpsters for trash and recycling

How to Clean Up:
Think about the size of your campus and the number of students/classes participating. You may want to divide your campus into regions in order to be able to collect more specific data. If you have multiple classes participating on different days, you may want to have them clean the same areas in order to quantify the amount of trash littered over a particular amount of time (and whether cleaning an area discourages further littering). It may be motivating to hold a competition between different classes to see who can collect the most trash. (Consider carefully how to encourage this, however, if you are attempting to collect accurate data from different locations. It may not be fair if classes are assigned to areas that naturally have different amounts of litter.) These decisions

may be made by the instructor or collaboratively after class discussion.

Here are some rules for students to follow during the cleanup:
1. Form teams of at least two, with one person assigned to write down the data. For groups of three or more, one person can hold the trash container, while the remaining members are Trash Pickers. Data Collectors will need pencils.
2. For Trash Pickers, only one glove is needed. Wear a glove on the hand you're using to pick up trash.
3. Don't pick up broken glass or other sharp objects. Notify your teacher or cleanup leader of the location.
4. Don't lift anything too heavy; when in doubt, be safe and don't try!

What to Pick Up:
Pick up only human-created matter (plastics, metal, Styrofoam, etc.). Natural debris (leaves, twigs, etc.) is part of the natural system and should be left alone. Much of the trash may be small, so keep your eyes out for smaller pieces. Small pieces are especially dangerous to animals who may mistake them for food.

Set up a lost-and-found spot for students to place items that appear to belong to someone (such as a notebook or gloves) and a spot for items that can be used (such as pencils or pens).

Separate recyclable materials into a separate bag or container. Confirm with your school as to what is acceptable for recycling.

Data Cards:
The information volunteers collect on data cards has been used to advance environmental legislation. It can also provide a way for students to determine issues of concern for their campus, and can be used for classroom data analysis and as a springboard for improving your campus environmental policies.
- Although there is not a space to list every single piece or type of trash we expect to see during the cleanup, volunteers should still pick up every piece of debris they find.
- When filling out cards, count items in groups of five as tally marks and record the final total in the box.
- Do not write the words "lots" or "many." Count every piece and be specific! Only actual numbers of items can be used.
- You are using official Coastal Cleanup Day data cards. As you can see, these cards include many items specific to a shoreline or waterway location, such as fishing gear. Take a look at the data card prior to your cleanup to familiarize yourself with which sections are most likely to be relevant to your schoolyard, and which sections you'll probably be able to ignore. (If desired, strike these items before printing cards for student use. Or have students discuss and decide what to strike.) There are some personal care products that you might decide are unlikely to be at your location and may cause a disruption for your students (e.g. condoms, tampon applicators). If so, you can white out those items. You may

want to replace them with more common schoolyard items like lip balm tubes or mint tins. There is also a section for "Items of Local Concern," which is where students can note and count items that are not found on the data card. (If you replace existing items in the data card, you'll need to remember that these new items will go in the "Local Concern" section if you plan to enter your data into the Coastal Cleanup Day database. See *Post-Cleanup* for details on the database.)

Finishing Up:
Have students bring their trash to a single location to be weighed. Using a bathroom scale, you can have a volunteer stand alone on the scale, then subtract that number from their weight when holding a bag of trash. Total the weight of all the trash collected.

Some groups prefer to do their data collection after the cleanup, by sorting their findings out on the ground. This can also serve as a dramatic temporary educational exhibit for the rest of the student body and staff.

Dispose of trash and recyclables appropriately in the school dumpsters. If there is no recycling on campus, perhaps a volunteer may be able to transport the recyclables home or to a collection facility.

Post-Cleanup

Adapted from "Clean Shorelines, Clean
Oceans," http://www.coastal.ca.gov/publiced/waves/waves_9_11.pdf,
from *Waves, Wetlands, and Watersheds*, http://www.coastal.ca.gov/publiced/waves/waves1.html
*(View NGSS and CCSS connections
at http://www.coastal.ca.gov/publiced/schoolyard/clean_shorelines_ngss.html)*

Back in the classroom, analyze the data collected at the cleanup:
1. Individually or in groups, provide students with copies of all the data cards. Decide how to tabulate the data. This can be decided through student discussion or by teacher direction. One option is to combine all cards from each region of your school onto one data card. Tabulation may be done as a homework assignment or it may be assigned to a designated student or students. Use spreadsheet software if available.
2. Break the students into small groups. Photocopy the data cards that contain the totals from the cleanup and give each small group a copy of one of the cards.
3. The class (or each small group) will choose a method for organizing the data. Some ideas include organizing by material (plastic, glass...), by suspected activity (lunch, sports, transportation...), by the debris item or brand, or another method that will provide information the students think is worthwhile.
4. Each small group will choose a method for displaying the data from their cleanup area: pie charts, line graphs, bar graphs... Use spreadsheet software if available.
5. Have each team share their visual presentation of the data with the class. Which was the most effective method of presenting the data? Which was most visually appealing? Which was the easiest to understand? Did they tell different stories?

6. After the presentations, conduct a whole class discussion that touches on relevant questions, such as:
   - Do certain items indicate specific sources of debris? (For example, are there straws from a campus juice box vending machine?)
   - Why is it important to know the location of the debris and the date of the sampling?
   - Where does most of the trash accumulate?
   - Which items of debris do students think are the most dangerous to wildlife?
   - How does it make them feel to see the trash on their campus?
   - How does it make them feel to see the campus clean after their work? Was it still clean the following day?
   - How can the data that was collected be used by the students and others to reduce litter and waste?

Compare your data to data collected at other cleanup locations by visiting an international database maintained by the Ocean Conservancy.
Visit www.coastalcleanupdata.org and click on *Guest Access*. You will be asked for a Name, Email, and brief explanation of why you want to view the data. (The database may be occasionally down for maintenance. If the site is down, please email us and we'll check in with the Ocean Conservancy.)

You can enter your own cleanup data into this database! To do this, you must register as an official Schoolyard Cleanup site.

What Next?

"Preventing Pollution at the Source," http://www.coastal.ca.gov/publiced/waves/waves_9_18.pdf, from *Waves, Wetlands, and Watersheds*, http://www.coastal.ca.gov/publiced/waves/waves1.html, has strategies for planning an action project with your students. (*View NGSS and CCSS connections to this activity at http://www.coastal.ca.gov/publiced/schoolyard/preventing_pollution_ngss.html.*)
Some potential action projects might include:
   - Read about 29 trash items (http://www.coastal.ca.gov/publiced/ccd/extinct.html) that are often found during California shoreline cleanups, and how you can help eliminate them. Compare these items to those that were found in your Schoolyard Cleanup. Why do you think you did or did not find these at school?
   - Write letters and/or make presentations to the principal, student council, PTA, superintendent and/or school board about problems of litter and waste that you identified on your campus. Prepare and present proposals to reduce the litter and waste.
   - Hold a "waste-free lunch" campaign, encouraging students to bring their own lunches in reusable containers. Find tips on waste-free lunches on our website at http://www.coastal.ca.gov/publiced/ccd/byo.html#wflunch. Be mindful of students who receive free and reduced-cost lunches at school, as it may not be

within their control to pack a lunch. Presenting cafeteria waste reduction suggestions to the principal or superintendent may a good alternative if this is an issue at your school.

- Make a display (collage, sculpture, or representation) of the trash collected during your cleanup. This display may be artistic (beautiful, grotesque...), it may be informative (with labels, charts...), or it may be both. Placing the display in a prominent place in the school can do a lot to educate the student body and staff.
- Write articles for the student or local newspaper about the cleanup and the data collected.
- Make presentations to other classes (or to classes at another school) about your cleanup and the data.

Science skills

- Observing
- Predicting
- Hypothesizing
- Analyzing

Concepts

- Water flows through and connects watersheds.
- Wherever you are, you are in a watershed.

California Science Content Standards

Earth Science

3. Water on Earth moves between the oceans and land through the processes of evaporation and condensation. As a basis for understanding this concept, student will know:

3.a. Most of Earth's water is present as salt water in the oceans, which cover most of Earth's surface.

3.d. The amount of fresh water located in rivers, lakes, underground sources, and glaciers is limited and that its availability can be extended by recycling and decreasing the use of water.

3.e. Students know the origin of the water used by their local communities.

Objectives

Students will:

- Investigate drainage patterns.
- Observe how watersheds distinguish different land areas.
- Discover the origin of the water used in their local community.

Time to complete

Two 50-minute periods. If making permanent watershed, allow at least three days for materials to dry before conducting experiments.

Mode of instruction

Small group model making followed by experiments and analyses.

Activity 5.3
Branching Out

Where does your water come from? Build a model watershed and predict where the water will travel across the land.

Background

The water cycle is the path water takes through its various states—vapor, liquid, and solid—as it moves through Earth's systems (oceans, atmosphere, ground water, streams, etc.). As we see a rushing stream or a river gushing during a major rainstorm, we may ask, Where does all this water come from? As we watch water flow down a street during a heavy rainstorm, we may ask, Where does all the water go? Answers may be found right in your own neighborhood! No matter how dry it looks, chances are there is water flowing far below your feet. Wherever you are, you are in a *watershed*, the land area from which surface runoff drains into a stream channel, lake, ocean, or other body of water.
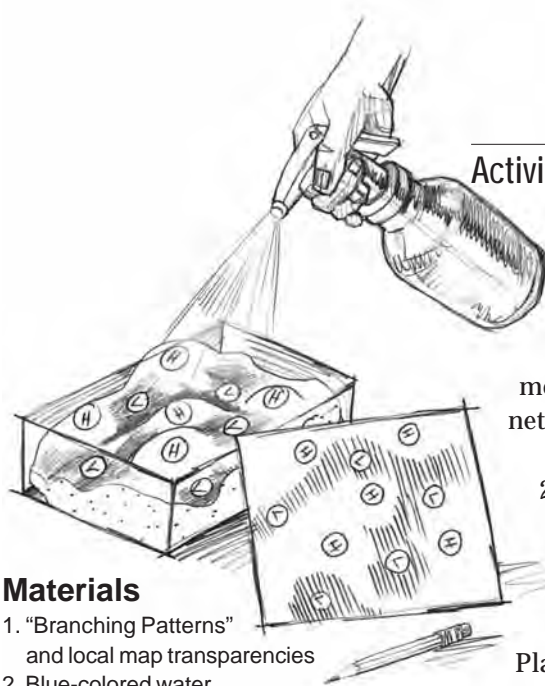
The pattern water makes as it flows through a watershed is familiar to students who have drawn pictures of trees or studied the nervous system. By investigating drainage patterns, we can better understand how watersheds distinguish different land areas.

When the ground is saturated or impermeable to water (when water cannot soak into the ground) during heavy rains or snowmelt, excess water flows over the surface of land as runoff. Eventually this water collects in channels such as streams. Watersheds are known by the major streams and rivers into which they drain.

Watersheds are separated from each other by areas of higher elevations called ridge lines or divides. Near the divide of a watershed, water channels are narrow and can contain fast-moving water. At lower elevations, the slope of the land decreases, causing water to flow more slowly. Eventually, water collects in a wide river that empties into a body of water, such as a lake or ocean.

From a bird's eye view, drainage patterns in a watershed resemble a network similar to the branching pattern of a tree. Tributaries, similar to twigs and small branches, flow into streams, the main branches of the tree. Like other branching patterns (e.g., road maps, veins in a leaf), the drainage pattern consists of smaller channels merging into larger ones.

Watersheds are either closed or open systems. In closed systems, such as Mono Lake in northeast California, water collects at a low point that lacks an outlet. The only way water leaves is by evaporation or seeping into the ground. Most watersheds are open—water collects in smaller drainage basins that overflow into outlet rivers and eventually empty into the sea.

Materials

1. "Branching Patterns" and local map transparencies
2. Blue-colored water
3. Spray bottles or sprinkling cans, one for each model
4. Drawing paper and pencil
5. Blue pencils
6. Tracing paper or blank transparency sheets
7. Photocopies of a local map showing rivers (watersheds also if available), one for each student
8. Overhead projector

Note: Students may build a temporary, simpler model, or a durable version that can be used for further experiments. Materials for both are listed here.

For both models

1. Five to ten rocks, ranging from 2 to 6 inches (5 to 15 cm) in height.
   If groups of students are making their own models, each group will need its own rocks.
2. Square or rectangular aluminum tray, large enough to hold rocks. A large disposable baking or turkey roasting pan will work.
3. Plastic wrap (thick plastic wrap from a grocery or butcher shop works best).

For temporary model

White scrap paper, newsprint, or butcher paper

For permanent model

Note: Allow extra time to make this model. Begin it at least three days before the experiments are to be conducted—the papier-mâché needs to dry overnight, and then the paint needs time to dry completely.

1. Papier-mâché materials (strips of newspaper dipped in a thick mixture of flour and water)
2. Water-resistant sealer and white paint (or white waterproof paint)

Activity

1. Ask students what they know about watersheds. Is there one near their home? (*Trick question: Wherever you live, you are in a watershed, even if that watershed is covered with asphalt.*) What is in a watershed? How can you tell one from another? Can you name a local watershed? Tell students they are going to build a model of a watershed to see how water flows through a branching network of drainages.

2. Depending on whether a temporary or more permanent model is being built, students will do the following:

   Temporary model

   Instruct students to select six rocks and wrap them with white scrap paper. Lay them in a square or rectangular aluminum tray. Place larger rocks near one end of the tray. Cover the paper-covered rocks with plastic wrap.

   Permanent model

   Instruct students to lay rocks in a square or rectangular aluminum tray, with larger rocks near one end. Snugly cover the rocks and exposed areas of the tray with plastic wrap. Apply strips of papier-mâché to cover the rocks. For a studier model, apply several layers of papier-mâché. When the mâché has dried, coat the model with white paint and waterproof sealant, or waterproof white paint.

3. Students will sketch a bird's eye view of the model. They should mark points of higher elevations with "H"s and low spots with "L"s. To identify possible ridgelines, connect "H"s.

4. Tell students the model will soon experience a rainstorm. Where do they think water will flow and collect in the model? Have them sketch their prediction on their drawings. Indicate the crevices in their models and possible locations of watersheds.

5. Students will spray blue-colored water over the model and note where it flows. Water may need to be sprayed for several minutes to cause a continual flow. Assist students in identifying branching patterns as water from smaller channels merges into larger streams.

6. Students will use blue pencil to mark on their drawings the actual branching patterns of water. Some imagination and logic may be required. Ask them to confirm the locations of watersheds by noting where water has collected in the model.

7. Ask students to determine if smaller watersheds overflow into larger ones. Does all the water in the model eventually drain into one collection site (open watershed system)? Does the model contain several closed water systems (collection sites that lack an outlet)?

8. Students will place tracing paper or an overhead transparency over their drawings and draw the drainage patterns. Groups compare and contrast each other's drawings. Discuss how the networks of smaller channels merge together to become larger.

Preparation

Collect materials, photocopy transparencies and maps, build models, and keep a space open in the room for the models to be worked on and displayed.

Outline

Before class:

1. Decide whether you will build the more durable and permanent watersheds or the lighter and more fragile temporary watersheds. Purchase or have students bring in appropriate materials (see list) based on this decision.
2. Have students bring in all other materials (rocks, blue pencils).
3. Photocopy map of the area around your school, with rivers and streams. One copy for each student.
4. Photocopy onto overhead transparency "Branching Patterns" sheet.

During class

1. Show overhead transparency of "Branching Patterns."
2. Arrange students into small groups of 3-4 students.
3. Using sample model making materials, illustrate how to make the model.
4. Distribute materials to each group.
5. Oversee model manufacturing (depending upon which model you choose, assembling the model will be completed in one day or over a series of days).
6. Allow students to proceed with experiments, roving from group to group to assist.
7. Whole class discussion on watersheds. ◈

9. Hand out photocopied maps of local area with streams, rivers, and lakes. Students locate streams and rivers and draw a circle around land areas they think drain into the river.

10. Students pick one river on the map and follow its path in two directions (upstream and downstream). If the entire river is pictured, one direction should lead to the headwaters or source, and the other direction merge with another river or empty into a body of water.

Results and reflection

1. Students predict where water will flow and collect in watershed model, and write their predictions on a piece of paper.
2. Students test their predictions and use the results to confirm or modify their projected drainage patterns.
3. Students will compare the drainage pattern of watersheds to other branching networks.
4. Students write a story about or draw a map of drainage patterns in their watershed. Label mountains, rivers, streams, reservoirs, lakes.

Conclusions

Watersheds have a branching pattern that distributes water from rain and snow into streams, rivers, and lakes. Water moves from high to low areas, collecting in drainage basins. These drainage basins are the source of water for most of our communities.

Extensions and applications

1. If the model were a real land area, would the drainage patterns be the same thousands of years from now? Students should consider the effects of natural and human-introduced elements (e.g., landslides, floods, erosion, evaporation, water consumption by plants and animals, runoff from agricultural fields, droughts, dams). Have students write one page describing what the future watershed looks like.
2. Students may finish their models by painting landscapes and constructing scale models of trees, wetlands, and riparian areas. Introduce human influences, such as towns and roads.
3. As in the game "Pin the Tail on the Donkey," blindfold students and have them randomly touch a point on a map of California. Have students explain likely routes water would take in that area. Where is the closest large river? Lake? Ocean? Are there dams on the river?
4. Students may make a topographic map of their model. First, they totally waterproof the model. Next, they submerge it, one-half inch at a time, in water. At each increment, while viewing from above, they trace the water level onto a sheet of glass or clear plastic held over the model. Students can make elevation lines and draw the map true to scale.

Adapted from

Branching Out is used with permission from Project WET/Montana State University from the *Project Wet Curriculum and Activity Guide.* For further information about Project WET (Water Education for Teachers), contact the national office at (406) 994-5392, or the California Project Wet, Water Education Foundation, (916) 444-6240, *www.watereducation.org*

Other References
Project GLOBE. www.globe.gov

Branching Patterns
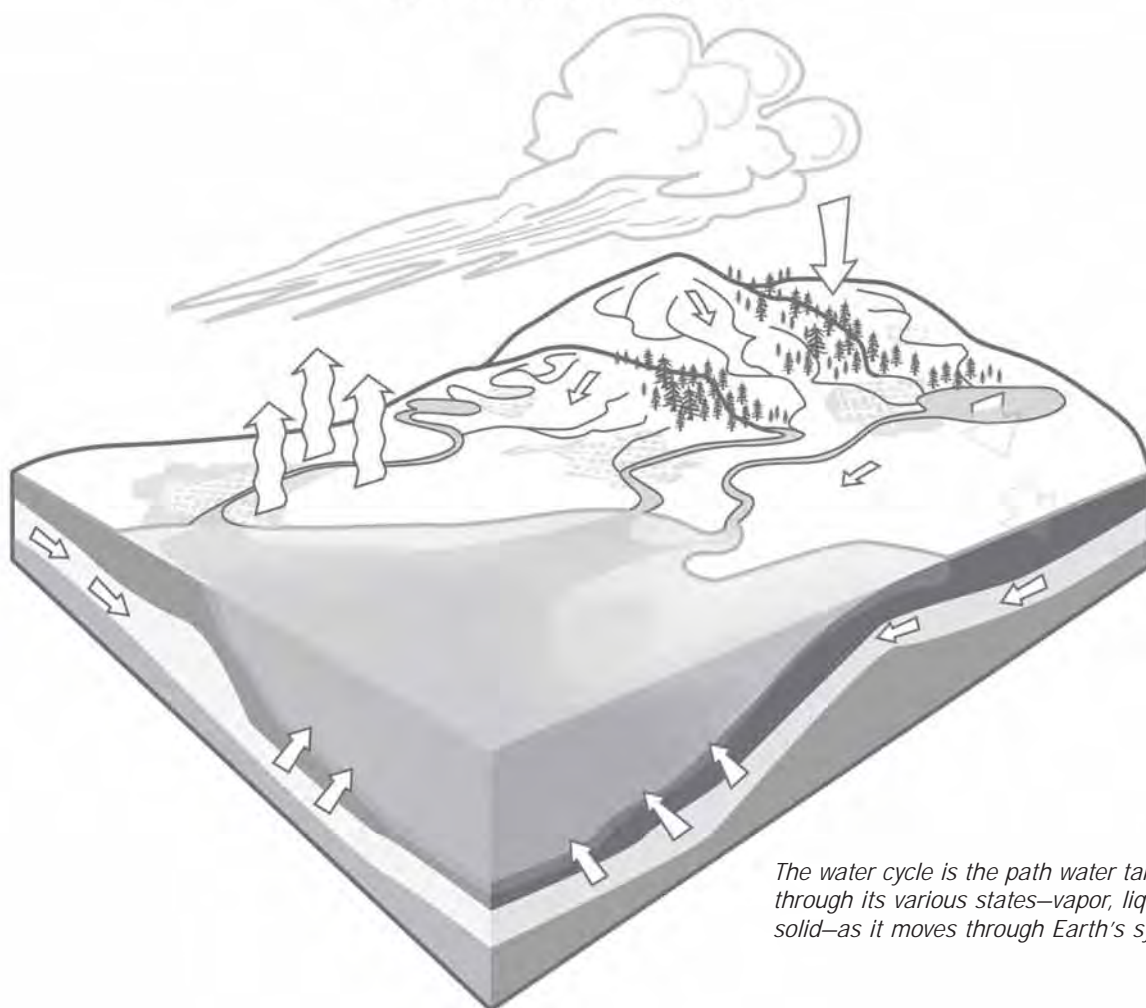
SECONDARY ROOTS FEEDING
PRIMARY TREE ROOTS

TRIBUTARIES FEEDING
MAIN WATERWAY

WATERSHED

The Water Cycle

The water cycle is the path water takes through its various states—vapor, liquid, and solid—as it moves through Earth's systems.

"Branching Out," Activity 5.3 in *Waves, Wetlands, and Watersheds*

NEXT GENERATION SCIENCE STANDARDS

Supports Crosscutting Concepts:
Patterns
Systems and System Models
Cause and Effect

Supports Science and Engineering Practices:
Asking questions and defining problems
Developing and using models
Planning and carrying out investigations
Constructing explanations and designing solutions
Obtaining, Evaluating, and communicating information

Supports Disciplinary Core Ideas:
PS2.B. Types of interactions

Supports Performance Expectations:
4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features.
5-PS2-1. Support an argument that the gravitational force exerted by Earth on objects is directed down.

SUPPORT FOR COMMON CORE STATE STANDARDS

5.W.3. Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.

Activity CA2
Searching Out Nonpoint Sources of Pollution
What is it, and what can you do to stop it?

Science skills
Map reading

Concepts
Nonpoint source pollution is a major problem to marine life. The good news is that each of us can be part of the solution.

Objectives
Students will identify nonpoint source pollution and how it affects both water quality and water organisms. Students will understand how consumer choices can reduce nonpoint source pollution.

Time to complete
50 minutes

Background
Land-based marine pollution can either be from a "point source" or a "nonpoint source." Point source pollution originates from a specific place such as an oil refinery or a paper mill. Nonpoint source pollution, on the other hand, is contaminated runoff originating from an indefinite or undefined place, often a variety of places (e.g., farms, city streets and parking lots, yards and landscaping, construction sites, and logging operations). The soot, dust, oil, animal wastes, litter, sand, salt, pesticides and other chemicals that constitute nonpoint source pollution often come from everyday activities such as fertilizing lawns, walking pets, changing motor oil, and driving. With each rainfall, pollutants from these activities are washed from lawns and streets into stormdrains that often lead directly to nearby bodies of water such as streams, rivers, and oceans.

While rarely visible, nonpoint source pollution is a chronic and ubiquitous form of coastal water contamination. The U.S. Environmental Protection Agency estimates that the primary cause of the pollutants in the ocean are not from point sources, but from various forms of contaminated runoff. The table on page 129 outlines examples of nonpoint source pollutants, their sources, and their effects.

Finding solutions to nonpoint source pollution is difficult, even if the sources can be identified and located. Often solutions involve major changes in land-use practices at the local level and expensive methods to minimize runoff. However, nonpoint source pollution does offer individual citizens an ideal opportunity for combating marine pollution. There are actions we can take every day that can help—by changing some of our habits, we can help reduce nonpoint source pollution. The first step is understanding what some of the common types of pollutants are that we put in the ocean every day. The next step is to look for alternatives to use in place of those pollutants. Using these alternatives, we can still have clean houses and luxuriant yards—and a healthy ocean!

Activity
1. Ask students what they know about nonpoint source pollution, and write their answers on the board. Have they heard of the term? Do they know what it means? What are some examples? (*Nonpoint source pollution is contaminated runoff originating from an indefinite or undefined place, often a variety of places, see list above.*)

Mode of instruction

Students study a local map to identify possible sources of nonpoint source pollution, followed by a classroom discussion on actions students can take to reduce nonpoint source pollution.

Materials

1. Local map of the community, photocopied for each student
2. Map of community's storm drain system from the local Department of Public Works (optional)
3. "Nonpoint Source Pollution" and "Safe Substitutes" handouts

Preparation

Contact your local Department of Public Works to get map of storm drains. Find map of local community that includes waterways. Photocopy maps and information sheets.

Outline
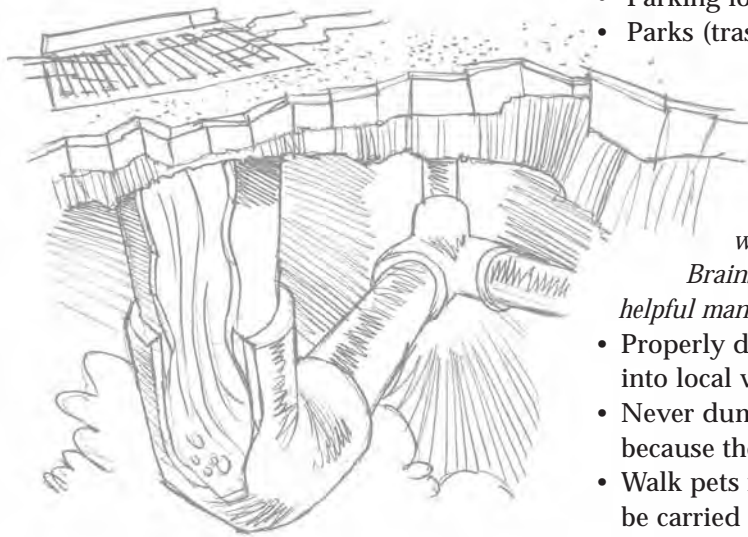
Before class

1. Photocopy maps of storm drains and local community, one for each student.
2. Photocopy "Nonpoint Source Pollution" and "Safe Substitutes" (one page, double-sided) for students to read and take home.

During class

1. Hand out maps for whole class discussion.
2. Hand out "Nonpoint Source Pollutants" and "Safe Substitutes" information sheets.

2. Next, ask students what types of nonpoint source pollution they think could be originating from their school and their community. Write this on the board.

3. Pass out the "Nonpoint Source Pollutants" and "Safe Substitutes" handout. Go over the list as a group.

4. Pass out a copy of a map of your community. Each student will now study the map and locate possible sources of nonpoint source pollution in your community. Some examples could include:

Schools
- Playground, football field (trash, fertilizers, pesticides)
- Sewage system, including restrooms, cafeteria, science classes (trash, excess nutrients, detergents, chemicals, pathogens)
- Parking lot (trash, heavy metals, dripping oil)
- Sidewalks and outdoor hallways (trash)

Community
- Farmland (sediments, excess nutrients, fertilizers, pesticides)
- Construction sites (trash, sediments)
- Residential areas (trash, fertilizers, pesticides, detergents from car washing)
- Parking lots (trash, heavy metals, dripping oil)
- Parks (trash, fertilizers, pesticides, animal waste)

5. Brainstorm with students about actions they *or their parents and caregivers* can take to reduce pollutants entering the marine environment. (*Note: Many of these are activities that adults would likely undertake; students would need to advocate these suggestions to their parents. Brainstorm with your students how they can approach adults in a helpful manner.*) Ideas could include:
- Properly dispose of trash in garbage cans. Storm drains empty into local waterways and can carry litter.
- Never dump chemicals on the ground or down storm drains because they may end up in the local stream, river, or bay.
- Walk pets in grassy areas or parks. Pet wastes on pavement can be carried into streams by storm water. Pick up after your pets.
- Do not pour chemicals down drains or toilets because they may not be removed in sewage treatment and can end up contaminating coastal waters. Use non-hazardous alternatives whenever possible (see "Safe Substitutes," page 130).
- Keep cars well maintained and free of leaks. Recycle used motor oil (contact local public works department or call (800) CLEANUP, for how to store and where to take waste oil).
- Don't dispose of leaves or grass clippings in your storm drain. Remember, storm drains usually lead to a body of water, and excess nutrients are a type of pollution. Instead, try composting yard waste.
- Landscape your yard to prevent runoff. Use as few pesticides as possible. Try "natural" (non-toxic) approaches to pest control wherever possible and use organic gardening techniques.

Searching Out Nonpoint Sources of Pollution

Results and reflection

1. Students locate their homes or neighborhoods on the maps. Then, draw on maps with a colored pencil or crayon the nonpoint source pollution originating from their homes and community, and track where it may go. Does it empty into a nearby waterway? Does it enter the ocean?

2. On the other side of the paper, students will list some possible solutions to reducing nonpoint source pollution from their homes and community.

Conclusions

Nonpoint source pollution presents a significant challenge to address on a large scale, as it is pervasive and difficult to control. However there is much we can do to reduce nonpoint source pollution at its source, beginning at home, extending to our schools, and out in our community.

Extensions and applications

1. Using the maps and information from this activity, create a nonpoint source pollution display for your school and/or community.

2. Find out what types of pollutants your school is generating (detergents, pesticides, fertilizers) and make a list. Discuss with school staff nonpoint source pollution, and suggest alternative products.

3. Conduct a storm drain stenciling activity around your school to alert people about the hazards of nonpoint source pollution. For information and stencils, contact The Ocean Conservancy at *stormdrain@oceanconservancy.org* or (757) 496-0920. You may also contact your local public works department to find out if they have a stenciling program.

4. Write to local or state representatives to find out what measures are being taken (or considered) to reduce nonpoint source pollution in your community. (Refer to Appendix D, *Make Your Views Known*, for letter-writing tips.)

Adapted from

Save Our Seas, A Curriculum for Kindergarten through Twelfth grades. The Ocean Conservancy (formerly known as Center for Marine Conservation) and California Coastal Commission, 1993.

Nonpoint Source Pollutants

Pollutant types	Sources	Effects
Marine debris (e.g., plastics, glass, metals, woods)	Runoff from roads, landfills, and parking lots into storm drains; sewer systems, beach and boating activities	Can harm marine life by entanglement or ingestion
Sediments	Construction sites; agricultural lands; logging areas	Clouds water, decreases plant productivity; suffocates bottom-dwelling organisms
Excess nutrients (e.g., fertilizers, animal wastes, sewage, yard waste)	Livestock; gardens; lawns; sewage treatment systems; runoff from streets	Prompts phytoplankton or algal blooms; causes eutrophication (depleted oxygen), and odor
Acids, salts, heavy metals	Runoff from roads, landfills, and parking lots; salt from roadway snow dumping sites	Toxic to marine life and can be taken up by organisms and bioaccumulate in their tissues
Organic chemicals (e.g., pesticides, oil, detergents)	Forests and farmland; anti-fouling boat paints; homes (lawns); golf courses; sewage treatment systems; street runoff	Chronic and toxic effects on wildlife and humans, possibly carcinogenic
Pathogens (e.g., coliform bacteria)	Municipal and boat sewage; animal wastes; leaking septic/sewer systems	Causes typhoid, hepatitis, cholera, dysentery
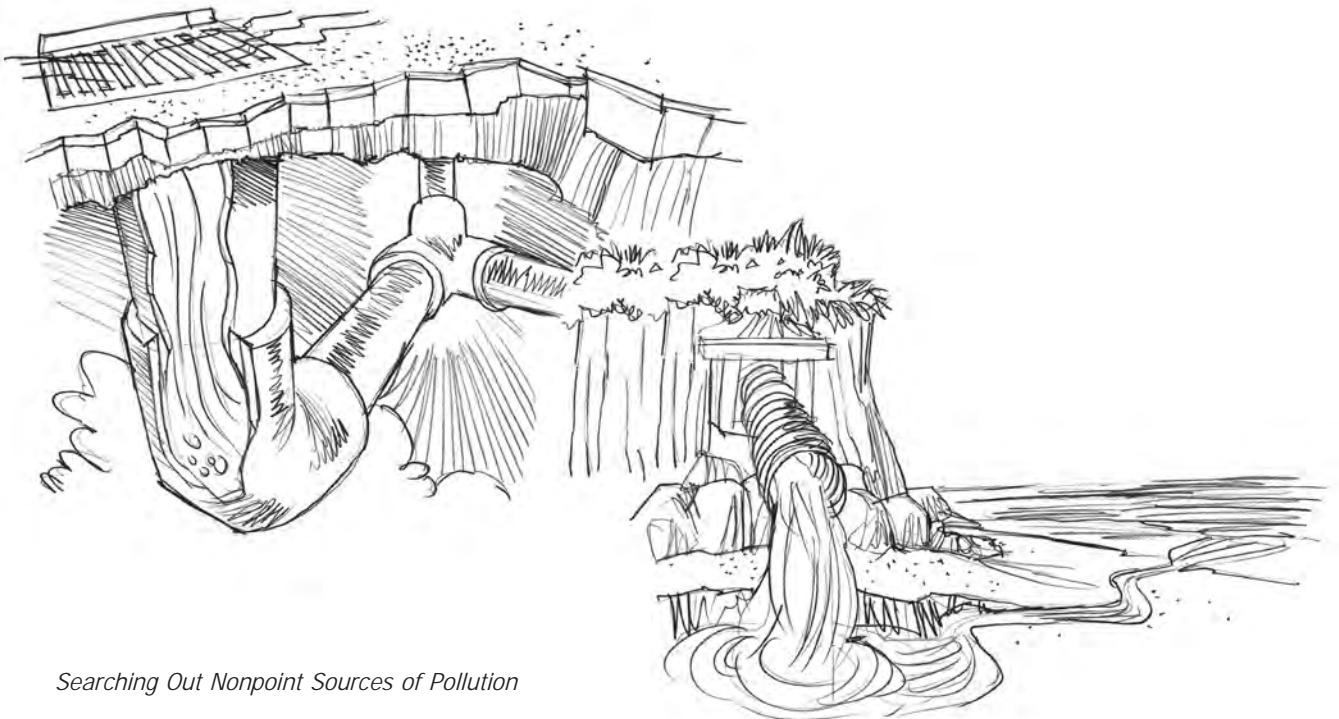
Safe Substitutes: Reduce Nonpoint Source Pollution

At Home

Air Fresheners
- For sink disposal odors, grind up used lemons.
- For surface odors on utensils and chopping blocks, add a few drops of white vinegar to soapy water.

Deodorizers
- For carpets, mix 1 part borax with 2 parts cornmeal; spread liberally and vacuum after an hour.
- Sprinkle baking soda in the bottom of cat boxes and garbage cans.

Dish Detergents
- Use mild, biodegradable, vegetable oil-based soap or detergent.
- For dishwashers, choose a detergent with the lowest phosphate content.

Disinfectants
- For disinfecting tasks, use ½ cup borax in 1 gallon hot water.

Drain openers
- Pour boiling water down the drain once a week.
- For clogs, add a handful of baking soda and ½ cup white vinegar to your drain, cover tightly and let sit 15 minutes while carbon dioxide bubbles work on clog. Finish with 2 quarts boiling water, follow with a plunger.

Floor cleaners
- For plain wood floors, use a damp mop with mild vegetable oil soap and dry immediately.
- For painted or varnished wood floors, combine 1 teaspoon of washing soda with 1 gallon of hot water. Rinse and dry immediately.
- For vinyl floors, combine ¼ cup white vinegar and ¼ cup washing soda with 1 gallon of warm water, and mop.
- For scuff marks on linoleum, scrub with toothpaste.

Furniture polish
- For finished wood, clean with mild vegetable oil soap.
- For unvarnished wood, polish with almond, walnut, or olive oil; be sure to remove excess oil.
- Revitalize old furniture with linseed oil.

Glass cleaner
- Combine 1 quart water with ¼ cup white vinegar.

Laundry detergent
- Avoid products containing phosphates and fabric softeners.

Bathrooms
- Combine ½ cup borax in 1 gallon of water for cleaning and disinfecting toilets.
- Clean toilets frequently with baking soda.
- Tub and sink cleaners: Use baking soda or a non-chlorinating scouring powder.

For the Garden

Garden fertilizers
- Use organic materials such as compost, either from your own compost pile or purchased from the store.

Garden weed and fungus control
- Use less-toxic soap solutions for weed killers.
- For fungus, use less-toxic sulfur-based fungicides.
- To control powdery mildew on roses, spray both sides of rose leaves (in the morning, weekly) with a mixture of 2 tablespoons mild liquid soap, 2/3 teaspoon baking soda, and 1 gallon water.

Pest control
- For outdoor ants, place boric acid in problem areas.
- For indoor ants and roaches, caulk entry points. Apply boric acid dust in cracks and insect walkways. Be sure it's inaccessible to children and pets (it's a mild poison to mammals).
- For garden aphids and mites, mix 1 tablespoon of liquid soap and 1 cup of vegetable oil. Add 1 teaspoon of mixture to a cup of water and spray. (Oil may harm vegetable plants in the cabbage family.)
- For caterpillars in the garden, apply products containing *Bacillus thuringiensis* to the leaves when caterpillars are eating.
- For mosquitoes in the yard, burn citronella candles.

Source: *Take Me Shopping: A Consumers Guide to Safer Alternatives for Household Hazardous Products.* Published by the Santa Clara County Hazardous Waste Management Program.

Watch Out for These Toxic Ingredients!

Degreasers: trichloroethylene (TCE), toluene, methylene chloride. **Disinfectants**: o-phenylphenol, phenol chlorobenzene, diethylene glycol. **Drain cleaners:** sodium hydroxide, potassium hydroxide, hydrochloric acid. **Dry cleaning fluids:** TCE, perchloroethylene (PERC), 1,1,1-trichloroethane (TCA), naptha..

Gasoline: benzene, paradichlorobenzene. **Oven cleaner**: methylene chloride, xylene, toluene, methyl ethyl ketone chloride, nitrobenzene. **Spot remover or cleaning fluid**: carbon tetrachloride, 1,1,1-trichloroethane (TCA), trichloroethylene (TCE), perchloroethylene (tetrachloroethylene, PERC). **Toilet bowl deodorizer**: paradichlorobenzene. **Upholstery cleaner**: TCE. Wood preservatives: pentachlorophenols (PCPs), arsenic.

"Searching Out Nonpoint Sources of Pollution," Activity CA.2 in *Waves, Wetlands, and Watersheds*

NEXT GENERATION SCIENCE STANDARDS

Supports Crosscutting Concepts:
Cause and Effect
Systems and System Models
Stability and Change

Supports Science and Engineering Practices:
Asking questions and defining problems
Developing and using models
Constructing explanations and designing solutions
Engaging in argument from evidence
Obtaining, evaluating, and communicating information

Supports Disciplinary Core Ideas:
ETS1.B. Developing possible solutions
ESS3.C. Human impacts on Earth systems
ETS1.A. Defining and delimiting engineering problems
LS2.C. Ecosystem dynamics, functioning, and resilience
LS4.D. Biodiversity and humans
ETS1.B. Devloping possible solutions

Supports Performance Expectations:
3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features.
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
MS-ETS1.1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

SUPPORT FOR COMMON CORE STATE STANDARDS

RI.4. Craft and Structure

W.8. Research to Build and Present Knowledge

RST.4. Craft and Structure

RST.7. Integration of Knowledge and Ideas

Activity 8.2
You Are What You Eat: Plastics and Marine Life

Just because you can't see it doesn't mean it isn't there. Whether it sinks or floats, plastics in the sea spell trouble for all the animals in the ocean. Find out the many ways marine life can be affected by plastics in their aquatic home.

Background

Many animals that live in the ocean come into contact with discarded plastic. Because this plastic is not natural to their environment, the animals don't recognize it or know what to do about it. They encounter plastics most often as a result of their feeding behavior. Often they get entangled in it, are cut and injured, or think it's food and try to eat it. The number of marine mammals that die each year due to ingestion and entanglement approaches 100,000 in the North Pacific Ocean alone (Wallace, 1985). Worldwide, 82 of 144 bird species examined contained small debris in their stomachs, and in many species the incidence of ingestion exceeds 80% of the individuals (Ryan 1990).

Science skills
- Predicting
- Analyzing
- Deducting
- Charting

Concepts
- Plastics in the ocean affect animals that live there through entanglement, laceration, suffocation, and ingestion.
- Different plastics have different buoyancies, so where and what a marine organism eats determines the type of plastics to which it will be exposed.

Plastics and Marine Life

The potential for ingestion of plastic particles by open ocean filter feeders was assessed by the Algalita Marine Research Foundation by measuring the relative abundance (number of pieces) and mass of floating plastic and zooplankton near the central high-pressure area of the North Pacific central gyre. (The gyre is a large recirculating area of water halfway between Los Angeles and Hawaii.) Plankton abundance was approximately five times higher than that of plastic, but the mass of plastic was approximately six times that of plankton. This area is far from land, and many types of marine life feed here.

Plastics don't go away, they just go somewhere else where we can't see them. The effects on marine life can be devastating. Aquatic animals may be harmed by plastic objects in a variety of ways, depending on the shape and buoyancy of the object. These animals may suffer injury or even death from their encounters with plastics. Animals can be harmed through entanglement, laceration, suffocation, and ingestion.

The buoyant properties of water allow some plastics to float, some to sink, and some to stay in the water column. The types of plastics marine animals may come into contact with depend upon where they live and eat: at the water's surface, its bottom, or floating in the water column between the surface and the bottom. All we can see are the plastics on the surface, but there are many different varieties and shapes of plastic objects below the surface. Because we can't see this pollution, we may forget that it exists. Marine animals know by first hand experience the devastating effects of plastics pollution in the ocean, but they aren't talking. As cities grow and more plastics are produced and enter the marine environment, marine species will continue to be affected unless we make wise choices regarding plastic use and disposal.

California Science Content Standards

8. All objects experience a buoyant force when immersed in a fluid. As a basis for understanding this concept, students know:

8.c. The buoyant force on an object in a fluid is an upward force equal to the weight of the fluid the object has displaced.

8.d. How to predict whether an object will float or sink.

Objectives

Students will:
- Understand that different types of plastics float, sink, or stay neutrally buoyant.
- Learn where ten marine species feed in the water column.
- Make connections between where a marine organism lives and feeds and the types of debris to which it is exposed.

Time to complete

One hour, including video

Mode of instruction

Watch video, then group or individual work with worksheet, chart, and cards, followed by presentation of results and whole class discussion.

Materials

1. Video—*Synthetic Sea: Plastics in the Ocean.* Borrow from California Coastal Commission education web site: *www.coastforyou.org*
2. "You Are What You Eat" worksheet
3. "Marine Animal Feeding Habits and Plastic Risk" chart
4. "Marine Animal Cards"
5. "Plastics and Their Uses" handout

Activity

1. Watch the video *Synthetic Sea: Plastics in the Ocean* with your class. Conduct a whole class discussion on what students think about plastics in the ocean. Does plastic just go away? What types of animals are most affected?

2. Next, conduct a whole class discussion on the many ways we use plastics in our daily lives.

3. Hand out "Plastics and Their Uses" and discuss the different types of plastics. Note that most cities only accept SPI 1 and 2 for recycling; though many of the other types of plastic are labeled as "recyclable," in reality, this does not occur and the majority of plastics end up in landfills.

4. From water bottles to computers, we rely on the convenience and availability of plastics to provide many of today's necessities. List on the board the shapes that plastic can come in, and have students give examples of what they are used for:
One-dimensional objects (line, rope, strapping bands)
Two-dimensional objects (sheets, bags)
Reticulated (netting, six-pack rings)
Hollow-bodied (bottles, fishing floats)
Small particles (Styrofoam, pellets used in making plastic objects)
Angular (boxes, crates)

5. Discuss the marine zones in which animals feed (surface, pelagic, and benthic). Have students brainstorm what types of animals might live and feed in each of these zones.

6. Either divide the class into small groups (3-4 students) or distribute materials to individuals. Distribute copies of the "You Are What You Eat" worksheet, "Marine Animal Feeding Habits and Plastic Risk" chart, and the "Marine Animal Cards" to groups or individuals.

7. Have students complete the worksheet activity. Keep in mind that there are many different possible "right" answers. What is important is that students have a rationale for their choices.

Results and reflection

1. After the groups or individuals have completed the activity, draw the chart on the board. Have each group or student choose one form of plastic (i.e., one-dimensional, two-dimensional, small particles, etc.) and present to the class their results and rationale of what species would be most affected.
2. Allow time to propose different answers, discuss them, and wrestle with different conclusions.
3. Conduct a whole class discussion on how to reduce the amount of plastics in the marine environment. (Refer to activity CA1: Marine Debris, It's Everywhere! for waste reduction ideas.)

Preparation

Order video *Synthetic Seas: Plastics in the Ocean* two to three weeks in advance. Photocopy worksheet, chart, cards, and table, one per student.

Outline

Before class

1. Order video *Synthetic Seas: Plastics in the Ocean* two to three weeks in advance of lesson from California Coastal Commission education web site, *www.coastforyou.org*.
2. Photocopy "You Are What You Eat" worksheet and "Marine Animal Feeding Habits and Plastic Risk" table, one for each student or group.
3. Photocopy and cut out "Marine Animal Cards," one set per student.
4. Photocopy "Plastics and Their Uses," one per student.

During class

1. Lead whole class discussion on characteristics of plastics in the oceans.
2. If working in groups, divide students into groups of 3-4.
3. Hand out worksheets, chart, and cards: students will arrange cards at their own tables.
4. Table groups or individuals present rationales and results to class. ◈

Conclusions

Marine organisms are besieged with plastics in their aquatic home. They can mistake plastic pieces as food and ingest them, or become accidentally trapped by plastic marine debris.

Extensions and applications

1. Have students bring from home different types of plastic trash, or use the trash from their lunches. Conduct buoyancy experiments to see which pieces float and which sink, and which are neutrally buoyant. Group like objects together based on buoyancy. Now check their recycle number on the bottom—the number in the triangle. Do all types of plastic with the same number have the same buoyancy? What might affect the buoyancy besides the type of plastic (e.g. the shape of the object).

2. Get a list from your local refuse agency that indicates what plastics they accept for recycling, and sort your plastic trash from #1 above accordingly. Are the recyclable plastics primarily floaters or sinkers? Do you think that the plastic that is more easily recyclable ends up in the ocean less often than those that are not recyclable in your area? Which ocean animals might recycling plastic help most?

Adapted from

Animals' Feeding Ranges and Plastics, *Plastics Eliminators: Protecting California Shorelines.* California Aquatic Science Education Consortium. CASEC c/o 4-H series, Loran Hoffman, Department of Human and Community Development, UC Davis, 1 Shields Ave., Davis, CA 95616. *www.rain.org/casec*

Further references on ocean pollution:
www.mi.mun.ca/mi-net/enviro/pollut.htm
http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/peril_pollution1.html
htpp://educate.si.edu/lessons/currkits/ocean/pollution/essay.html
www.occdsb.on.ca/~sel/newswave/ocean1.htm
www.ocean.com/conservation/oceanpollution.asp
www.umassd.edu/public/people/kamaral/thesis/plasticsarticle.html
www.coastal.ca.gov/publiced/marinedebris.html

Answer Key: Marine Animal Feeding Habits and Plastic Risk*

	One dimensional	Two dimensional	Reticulated	Hollow	Small	Angular
Surface Feeders	6	6	9	7	3,7,9	
Pelagic Feeders	4,5	6,8	4, 8	1,2,4,5	10	2
Benthic Feeders	4	6	2	2	10	2

*Note: These are some possible answers. Your students may have additional answers with plausible rationales. This is an area of active scientific investigation; we have yet to learn the extent of devastation caused by plastic marine debris.

You Are What You Eat

Do different forms of plastic affect animals feeding in different parts of the ocean? Here is some information that will help you answer this question and fill out your Marine Animal Feeding Habits and Plastic Risk chart.

The Three Marine Zones

Scientists divide bodies of water into three basic areas:
1. *The surface zone:* the very surface of the water where it meets the air and things float where you can see them.
2. *The pelagic zone:* the open water below the surface where neutrally buoyant fish swim and plankton float.
3. *The benthic zone:* what lies beneath the bottom of the of water; consists of mud, sand, or rock.

Where Marine Life Eats

Different forms of marine life gather their food in different zones. For example, some birds are surface feeders. They skim along just above the ocean's surface, and scoop up small bits of floating fish. Many fish are pelagic feeders. They swim about, eating smaller animals, plankton, and other food that share the water with them. Many whales, turtles, seals, and diving birds are pelagic feeders. Other kinds of fish, turtles, whales, and sea otters swim along the bottom to scoop up food from the ocean floor. They are called benthic feeders.

Animals that feed in different areas of the ocean often interact with different forms of plastic. For example, a bird skimming the ocean surface might accidentally scoop up bits of floating plastic pellets thinking they were food, but wouldn't scoop up a large, floating, angular object such as a Styrofoam ice chest, or a hollow object such as a plastic bottle.

Activity Directions

1. Arrange each card in your packet on the chart so that the animals are:
   • located under the form of plastic they will have trouble with and,
   • next to the zone where they feed

2. Then, take the card off of the square and write the animal's name in the square. One animal may be affected by more than one type of plastic, and may feed in more than one habitat, so there will likely be more than one animal name in a square.

3. You will compare charts with other students. Be sure to be able to explain your rationale for placement.
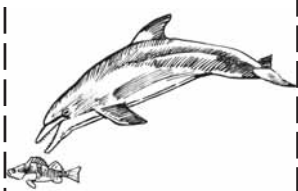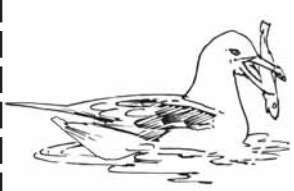
Marine Animal Feeding Habits and Plastic Risk
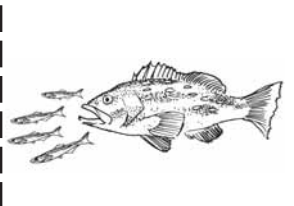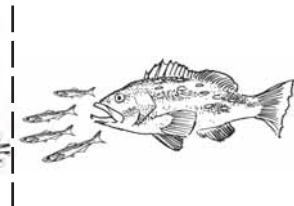
	One-dimensional Objects	Two-dimensional Objects	Reticulated Objects	Hollow Objects	Small Particles	Angular Objects
Surface Feeders						
Pelagic Feeders						
Benthic Feeders						

You Are What You Eat
Marine Animal Cards

Photocopy and cut along dotted lines.
Each student receives one complete set.

1. Bottlenose dolphin: feeds on surfperch in open water below surface, grabs with teeth.

2. Orca: eats fish and marine mammals, grabs with teeth. Feeds in open water below surface.

3. Gull: eats fish, inter-tidal organisms, beach debris. Feeds on shore, top of water, grabs food with beak.

4. Sperm whale: eats squid and fish below surface. Grabs food with long, narrow mouth.

5. Common dolphin: feeds below surface in open water. Grabs small squid, other small fish with teeth.

6. Loggerhead sea turtle: eats jellies, fish, mussels, clams, crabs; grabs them with toothless mouth.

7. Elegant tern: feeds on anchovies and other fish, floats or dives shallowly into the water.

8. Sea bass: feeds below surface in open water, sucks herring, krill, and anchovies into its large mouth.

9. Forster's tern: feeds on various small fish floats along or dive shallowly into water.

10. Sea otter: feeds on benthic urchins and shellfish, bringing them to the surface to eat.

1. Bottlenose dolphin: feeds on surfperch in open water below surface, grabs with teeth.

2. Orca: eats fish and marine mammals, grabs with teeth. Feeds in open water below surface.

3. Gull: eats fish, inter-tidal organisms, beach debris. Feeds on shore, on water, grabs food with beak.

4. Sperm whale: eats squid and fish below surface. Grabs food with long, narrow mouth.

5. Common dolphin: feeds below surface in open water. Grabs small squid, other small fish with teeth.

6. Loggerhead sea turtle: eats jellies, fish, mussels, clams, crabs; grabs them with toothless mouth.

7. Elegant tern: feeds on anchovies and other fish, floats or dives shallowly into the water.

8. Sea bass: feeds below surface in open water, sucks herring, krill, and anchovies into large mouth.

9. Forster's tern: feeds on various small fish floats along or dive shallowly into the water.

10. Sea otter: feeds on benthic urchins and shellfish, bringing them to the surface to eat.

For use with Activity 8.2: You Are What You Eat: Plastics and Marine Life

Plastics and Their Uses

Name	SPI Code	Description	Uses
PET (Polyethylene terephthalate)	1	High strength; transparent; barrier to gas and moisture, resistant to heat; **sinks in water**.	Plastic soft drink and water bottles, beer bottles, mouthwash bottles, peanut butter and salad dressing containers, ovenable pre-prepared food trays.
HDPE (High density polyethylene)	2	Tough; chemical and moisture resistant; permeability to gas; translucent or opaque matte finish; **floats in water**.	Milk, water and juice containers, trash and retail bags, liquid detergent bottles, yogurt and margarine tubs, cereal box liners.
PVC (Polyvinyl chloride)	3	Hardy; chemical resistant; resistant to grease/oil; transparent, translucent or opaque; **sinks in water**.	Clear food packaging, shampoo bottles, medical tubing, wire and cable insulation.
LDPE (Low density polyethylene)	4	Tough; lightweight; barrier to moisture; can be nearly transparent or opaque; low to high gloss; **floats in water**.	Bread bags, frozen food bags, squeezable bottles, fiber, tote bags, bottles, clothing, furniture, carpet.
PP (Polypropylene)	5	Hard; resistant to chemicals; resistant to heat; barrier to moisture; resistant to grease/oil; transparent, translucent, or opaque; **floats in water**.	Ketchup bottles, yogurt containers and margarine tubs, medicine bottles
PS (Polystyrene)	6	Stiff; transparent or opaque; smooth surface; **sinks in water.**	Compact disc jackets, aspirin bottles.
EPS (Expanded polystyrene)	6	Lightweight; heat resistant; insulating; opaque; foamed**; floats in water.**	Food service applications, grocery store meat trays, egg cartons, cups, plates.

"You Are What You Eat: Plastics and Marine Life," Activity 8.2 in _Waves, Wetlands, and Watersheds_

NEXT GENERATION SCIENCE STANDARDS

Supports Crosscutting Concepts:
Cause and Effect
Structure and Function

Supports Science and Engineering Practices:
Asking questions and defining problems
Developing and using models
Constructing explanations and designing solutions
Engaging in argument from evidence
Obtaining, Evaluating, and communicating information

Supports Disciplinary Core Ideas:
ESS3.C. Human impacts on Earth systems
LS2-A. Interdependent relationships in ecosystems

Supports Performance Expectations:
MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

SUPPORT FOR COMMON CORE STATE STANDARDS

SL.1. Comprehension and Collaboration
RST.1. Key Ideas and Details
RST.4. Craft and Structure

Science skills
- Identifying
- Classifying
- Hypothesizing
- Cataloging
- Graphing

Concepts
- Humans affect ocean ecosystems and marine wildlife.
- Through our efforts, we can make a difference in the amount of trash that enters the oceans.

Objectives
- Students will demonstrate the role they can play in marine conservation by participating in a shoreline cleanup.
- Students conduct the shoreline cleanup according to a scientific method.

Time to complete
Field trip to the beach, river, lake site: 2-3 hours at the site

Mode of instruction
Classroom discussion and preparation for field trip, then field trip to shoreline followed by data analysis in the classroom.

If you would like to do your cleanup on California Coastal Cleanup Day, it is held on the third Saturday in September. Begin planning as soon as school starts in the fall!

Activity CA3
Clean Shorelines, Clean Oceans: Shoreline Cleanup

Tons of marine debris are picked up each year off California's beaches, river banks, and lake shores. Be a part of the solution—do a shoreline cleanup with your class. You never know what you may find!

Background
If your students have completed the activities CA1: *Marine Debris— It's Everywhere!* and CA2: *Searching Out Nonpoint Sources of Pollution*, they will have an understanding of the many types of marine debris and its hazardous effects on wildlife. Now is the time to put this newfound awareness into action with a shoreline cleanup. The shoreline cleanup allows the students to participate in an immediate solution to the problem of marine debris; simultaneously, the students employ scientific methodology to analyze the problem of marine debris. They will form a hypothesis, decide on their purpose, follow a particular method, summarize their results, and make a final conclusion.

Picking up trash from beaches and waterways so it doesn't enter the oceans and harm marine life is clearly an important job. Why collect data on what you find? By collecting data, students can begin to understand the types and amount of trash littering the beach. From this information, students can also determine some possible sources of the debris. By determining what type of trash is littering the shore and how it might have arrived there, students will discover that marine debris is caused by human behavior. We all use and discard products that can become part of the problem, and by understanding this connection, we can begin to develop solutions to the problem. There are actions that we can take every day that can reduce marine debris.

Activity
Follow instructions under "Outline" (in the sidebar, p. 134) for preparation for field trip.

1. The day before the field trip, discuss these steps of scientific methodology with your students:
Purpose: Students will come up with a purpose for their scientific study. A likely purpose might be, "I want to understand where marine debris comes from."
Hypothesis: Have your students come up with hypotheses they can test by collecting data during the cleanup. Possible hypotheses might include: "There is more marine debris farther up the beach than closer to the water." Or, "There is more plastic debris than any other type of debris."
Method: Students will break into teams to comb two different sections of the beach. One team will clean near the water line, another will clean the upland portion of the shore. Within each team, students will break into groups of 3-4 students to cover a segment of their section. In each group, one student will be the recorder, one student will hold the trash

Materials

1. Separate bags for trash and recyclable debris
2. "Shoreline Cleanup Data Card" (There are two options available. *Option A* groups debris by its substance. This card allows for a reflection activity in which students determine what human actions led to the debris ending up on the shore, and allows them to understand which materials are most abundant. *Option B* is used by volunteers throughout the world during the International Coastal Cleanup. With this card, students organize the debris into source categories as they collect it.)
3. Clipboard and pencil for each small group (3-4 students)
4. School parental consent form
5. Adopt-a-Beach waiver form (if applicable)
6. First aid kit
7. Gloves (two for each small group)
8. Tide chart

and recycle bags, and two students with gloves will pick up the trash. Students will switch jobs half way through, so all students have an opportunity to pick up trash. Every item that is picked up is recorded on the data sheet. The groups will discuss and agree to which "category" each piece of debris belongs. If there is a question, the student should ask the teacher or adult supervisor (i.e., some debris will include both plastic and metal).

2. The morning of the cleanup, check weather conditions at the cleanup site and review the following safety information with the students:
   - Do not go near any large metal drums.
   - Do not pick up any sharp objects – inform an adult where the sharp object is located.
   - Notify an adult if you find a syringe.
   - Debris collectors wear gloves.
   - Stay out of dunes and any protected areas.
   - Watch out for wildlife and do not approach any animals you encounter.
   - Don't lift anything too heavy.
   - If you begin to feel very hot, dizzy or tired, drink some water and notify an adult.
   - If you are walking near the surf, never turn your back to the ocean.

3. At the site, select a stretch of shoreline that the teams will cover. Make sure you have adequate supervision of the teams if the stretch is a wide one (choose the stretch according to the age of your class, cover a wide stretch with older children, or a shorter one with younger).

4. Instruct students to keep their eyes open to possible clues as to debris sources, e.g. are there adequate trash cans, is there a nearby storm outfall, does the site get heavy use, do people fish in the area?

Preparation

Select a public site for the cleanup and a field trip date. For locations on the coast, San Francisco Bay, and some inland waterways, call (800) Coast-4U or visit www.coastforyou.org to find a local Adopt-A-Beach manager. (If you wish to hold your cleanup on Coastal Cleanup Day, the third Saturday in September, use the same phone number and webpage to obtain local participation information.) The beach manager will assist you in selecting a clean up location and will supply you with bags, gloves, and waivers for your students. Arrange with the beach manager to have the trash and recycling collected after your cleanup.

If you would like to do a shoreline cleanup and are in an inland area that is not covered by the Adopt-A-Beach program, try contacting your local city or county public works department for assistance with supplies or find a local citizens' group that holds cleanups in your area. (Check the on-line "Marine, Coastal & Watershed Resource Directory" at *www.coastforyou.org.*)

5. Have students assemble into their two teams (waterline and upper shore). Within their teams, have students break up into groups of four students:
    1. Data writer
    2. Debris bag holder
    3. Debris collector
    4. Debris collector

6. Within each group of four, distribute one trash bag, one recycling bag, two gloves (one for each of the two people who will pick up debris) and one data card with clipboard and pencil.

7. Define the boundaries of the project for the students and adult volunteers so no one strays away. Set a time for the completion of the cleanup and a meeting place, and identify a way of telling students when it is time to return (e.g., three blows on a whistle, a special class-room signal or call, etc.). Remind the students to only work in their designated area (water line or upper shore).

8. After the cleanup, pile the bags in two designated areas: one for recyclables, and one for nonrecyclables. Collect the clip boards and data cards. Have lunch and congratulate yourselves on a job well done. Be sure not to leave any trash from your lunches behind! You may place your trash in your bags.

Results and reflection

Back in the classroom, analyze the data collected at the cleanup:

1. Individually or in groups, provide students with copies of all the data cards. Have them tabulate the data card totals onto two new data cards—one for the water line and one for the upper shore. (This may be done as a homework assignment or it may be assigned to a designated two students if you prefer.)

2. Break the students into their small groups of four. Photocopy the two data cards that contain the totals from the beach cleanup and give each small group a copy of the card for the area that they cleaned up.

3. If Data Card Option A was used, the class (or each small group) will choose a method for organizing the data. Some ideas include keeping it organized by material (plastic, glass…), or organizing it by the source activity (fishing, littering, dumping...), or by the manner in which they think the debris reached the beach (from boats, from beach-goers, through storm drains…). You may choose to have students transfer their data to Data Card Option B to help guide them to possible conclusions as to the source of the debris.

4. Each small group will choose a method for displaying the data from their cleanup area: pie charts, line graphs, and/or bar graphs.

5. Have each team share their visual presentation of the data with the class. Did the results confirm the hypotheses that were made before the cleanup? Which was the most effective method of presenting the data? Which was most visually appealing? Which was the easiest to under-stand? Did they tell different stories?

Outline

Before class

Two weeks to one month before cleanup:

1. Select a cleanup site. The shoreline should be sand or gravel and known to collect litter.
2. Begin assembling the materials and support you need. (Decide whether to use Data Card *Option A* or *Option B*. Page 2 backside will be the same for either option.)
3. Arrange transportation to the site.
4. If using the Adopt-A-Beach Program, send the school's parental consent form and the Adopt-A-Beach waiver form home with the students to be signed and returned.
5. You may wish to obtain a SHARPS container for syringes the students may discover. Your local fire department can assist you.

Day before cleanup

1. Collect parental consent forms.
2. Break the class up into two teams. One team will be responsible for the upland portion of the shoreline (if there are dunes at the beach, this team will clean up the beach-side of the dunes). The other team will be responsible for the water line. Within each team, students will break out into small groups of four students.
3. As a group, predict the type of debris that each group will find. Will there be a difference? Why?
4. Discuss the purpose of the cleanup.
5. Go over the data cards with the students.
6. Remind the students to wear appropriate clothing for the cleanup: layers, closed-toed shoes, hats and sun screen. Suggest that they bring a bottle of drinking water for their own use during the field trip as well as a bag lunch. (You may want to encourage the students to try to create a "trash-free" lunch, using recyclable and reusable containers.)
7. Photocopy data cards (*Option A* or *Option B*), one per each group of four students.

Day of cleanup

Follow activity instructions.

Day after cleanup

Data analysis and classroom discussion.

6. After the presentations, conduct a whole class discussion that touches on relevant questions, such as:
- Where is the trash coming from?
- Do certain items indicate specific sources of debris? (For example, fishing nets represent the fishing industry and are an ocean-based source of marine debris.)
- How can the information that was collected be used by the students and others to reduce marine debris? (Perform Activity CA4 to delve further into this topic.)
- Why is it important to know the location of the debris and the date of the sampling? Where does most of the trash accumulate? Which items of debris do they think are the most dangerous to marine wildlife?
- How does it make them feel to see the trash along the beach?
- How does it make them feel to see the beach clean after their work?

Conclusions

A cleanup helps us care for our shorelines and oceans, and tells us about what types of debris builds up on the shore. Knowing this, we can make some lifestyle choices to reduce marine debris.

Extensions and applications

1. Ask students to bring a "trashless" lunch to the cleanup, using reusable containers. Discuss alternatives to plastic sandwich bags, paper lunch sacks, disposable drink containers, etc.
2. Make a display of the trash collected.
3. Write an article about your beach cleanup for school or local newspaper (See Appendix D, *Make Your Views Known*).

Adapted from

Save Our Seas, A Curriculum for Kindergarten through Twelfth grades. The Ocean Conservancy (formerly known as Center for Marine Conservation) and California Coastal Commission, 1993.
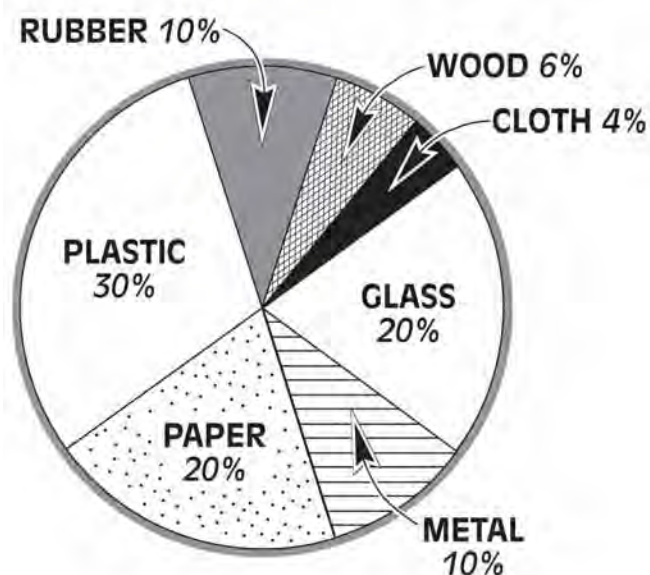
"Clean Shorelines, Clean Oceans," Activity CA.3 in *Waves, Wetlands, and Watersheds*

NEXT GENERATION SCIENCE STANDARDS

Supports Crosscutting Concepts:
Patterns
Cause and Effect
Structure and Function

Supports Science and Engineering Practices:
Asking questions and defining problems
Developing and using models
Planning and carrying out investigations
Analyzing and interpreting data
Using mathematics and computational thinking
Constructing explanations and designing solutions
Engaging in argument from evidence
Obtaining, Evaluating, and communicating information

Supports Disciplinary Core Ideas:
LS2.C. Ecosystem dynamics, functioning, and resilience
LS4.D. Biodiversity and humans
ESS3.C. Human impacts on Earth systems
ETS1.A. Defining and delimiting engineering problems
ETS1.B. Devloping possible solutions

Supports Performance Expectations:
K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.
2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.
3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

SUPPORT FOR COMMON CORE STATE STANDARDS

W.1. Text Types and Purposes (Ext. #3)
W.2. Text Types and Purposes (Ext. #3)
W.7. Research to Build and Present Knowledge
W.8. Research to Build and Present Knowledge
SL.1. Comprehension and Collaboration
SL.4. Presentation of Knowledge and Ideas
SL.5. Presentation of Knowledge and Ideas
MP.4. Model with mathematics
2.MD.10. Represent and interpret data
HS.N-Q. Reason quantitatively and use units to solve problems.

Science skills
- Analyzing
- Problem solving

Concepts
- A specific problem definition will facilitate the development of effective solutions.
- Brainstorming is an effective approach to begin the problem solving process. It can be used to explore marine debris issues and solutions.

Objectives
- Students will be able to utilize a cooperative problem solving process designed to reduce marine debris.
- Students will implement their solution.

Time to complete
One hour

Mode of instruction
Students develop ideas to reduce marine pollution, analyze and evaluate the best ideas, and select the best one for actual implementation.

Materials
Overhead transparency of brain-storming tips

Preparation
Prepare overhead transparency.

Outline
Before class
Prepare overhead transparency.

During class
1. Divide students into small groups.
2. Assign or have students choose roles.
3. Display brainstorming tips overhead transparency. Students hold small group discussions. Each group reports on their solutions to the class.

Activity CA4
Preventing Pollution at the Source

From taking part in previous activities in this chapter, students now are familiar with how debris can pile up on the beaches. Now they will develop solutions to the problem of marine pollution.

Background
Students will learn how research and data collection can be used to develop solutions to environmental problems. Students will develop and try to implement solutions to the marine debris problem. No matter how young or old we are, we can all make a difference!

Activity
The Problem Solving Process
1. Hold a class discussion on the problem solving process (see page 140).

2. Tell students that they are now going to use the problem solving process to address the issue of marine debris. Write on the board the different steps and explain them:
   a. Understand and define the problem(s)
   b. Brainstorm solutions
   c. Analyze the solution suggestions
   d. Evaluate which solutions would be most effective and select the best solution.

3. Divide students into small groups (3-4 students). In the groups, assign roles or have students choose a role: recorder, discussion leader, spokesperson.

4. Display "Brainstorming Tips" on the overhead projector for students to refer to in their groups. Tell students they will now use the problem solving process discussed earlier to create solutions to problems associated with marine debris.

Results and reflection
1. Each group presents their problem definition and solution plan to the class. Ask for questions and comments. Ask that students note the ways their proposal could be improved.
2. The class selects the best plan by voting.
3. Elaborate on the best solution—describe it clearly. Would graphs, charts, or time lines help? Help the students design a graphic presentation of the classes' chosen solution. Then, have students create an action plan with timeline for implementation of their class solution.
4. Help students implement the action plan or send the recommendation to the appropriate city, county, or state agency. Consider the following for implementation: Which groups need to know about the proposal? Which groups will initially oppose it and how can their concerns be satisfied? What persuasive and educational techniques will be needed? Who will perform each task? Depending upon the age of your class, you may need to have suggestions ready for them to choose (e.g., local

Department of Public Works, EPA, California Coastal Commission, Harbormaster, etc.). Assist students in defining tasks and draw up a plan of action with names, tasks, and dates. Refer to Appendix D, *Make Your Views Known,* for ideas on effective letter writing techniques.

Conclusions

Humans are the source of marine debris, and we are also the solution. There are many ways we can work to reduce the marine debris polluting our oceans.

Extensions and applications

Invite someone from the school administration or community to class to help evaluate the class's proposed solutions.

Adapted from

Save Our Seas, A Curriculum for Kindergarten through Twelfth grades. The Ocean Conservancy (formerly known as Center for Marine Conservation) and California Coastal Commission, 1993.

WHAT IS THE GOVERNMENT DOING?

For centuries it was common practice for ships to dump their garbage at sea. The United Nations administers a treaty that provides a comprehensive approach to dealing with ocean dumping. The International Convention for the Prevention of Pollution from Ships is known as MARPOL 73/78 (MARine POLlution) and contains Annexes that deal with specific discharges: Annex I oil, Annex II hazardous liquids, Annex III packaged hazardous materials, Annex IV sewage, and Annex V garbage (including plastics). In order to implement MARPOL Annex V, the U.S. Congress passed the Marine Plastic Pollution Research and Control Act of 1987, which applies to both U.S. vessels and foreign vessels in U.S. waters.

Recently, it has become more and more evident that marine debris is also coming from land-based sources. Among these sources are combined sewer overflows. Usually found in older cities, these sewer systems are combined with stormwater drainage systems. When it rains, and too much water goes into the system, overflows of raw sewage and untreated pollutants from the streets are discharge *directly* into waterways. Discharges from land-based sources are subject to regulation under a federal law called the Clean Water Act.

Land-based sources also include urban runoff from storm drains. It is a common misconception that the pollutants and debris washed down storm drains are removed at a treatment plant. In most cases, this runoff is discharged directly into local streams, rivers, and bays with no treatment whatsoever. The U.S. Environmental Protection Agency (EPA) requires cities with separate storm sewer systems to obtain a National Pollutant Discharge Elimination System (NPDES) permit. Cities must apply for this permit to ensure that their stormwater systems are operating as efficiently and cleanly as possible and that they are educating their citizens about the hazards of dumping debris and other substances down storm drains.

Other laws protecting coastal water quality include the federal Coastal Zone Management Act of 1972, the Beaches Environmental Assessment and Coastal Health Act of 2000 (BEACH Act), and the California Coastal Act of 1976, which guides the actions of the California Coastal Commission.

From: *Pocket Guide to Marine Debris*, The Ocean Conservancy

Brainstorming Tips

1. Don't Criticize Others' Ideas
They will lose their train of thought and stop generating ideas.

2. More is Better
Write down as many ideas as you can. At this stage, don't worry about spelling, repetition, etc.

3. Connect Ideas When Possible
If something someone says sparks a thought, say your idea. Connect parts of your ideas with theirs when possible.

4. Be Free Wheeling and Don't Be Afraid to Express Crazy Ideas
A crazy idea now may seem plausible and original after more thought and research.

———

The Problem Solving Process
(Format for a class discussion)

Why is it important to understand and define the problem(s) before beginning to explore solutions? The more accurately and specifically a problem is defined, the easier it is to come up with effective solutions.

What are some examples of how different problem definitions might lead to different solutions? One problem definition might focus on the large numbers of cigarette butts found on beaches; another might focus on a lack of trash receptacles at a beach. If your students have participated in a shoreline cleanup, remind them about the data they gathered and analyzed during the cleanup, and the problems they identified. Is there anything else you observed at the shoreline that could help define the problems? If your students did not do a shoreline cleanup, discuss the problems they identified and learned about in CA1: *Marine Debris—It's Everywhere*, and CA2: *Searching Out Nonpoint Sources of Pollution.*

As a group, identify some examples of problem definitions for which the students will explore solutions. Discuss some possible solutions. The solutions could be as simple as initiating a letter writing campaign or as complex as working to get a law passed. For example, students in Massachusetts helped pass a law banning mass balloon releases.

Preventing Pollution at the Source, Activity CA.4 in *Waves, Wetlands, and Watersheds*

NEXT GENERATION SCIENCE STANDARDS

Supports Crosscutting Concepts:
Cause and Effect
Stability and Change

Supports Science and Engineering Practices:
Asking questions and defining problems
Constructing explanations and designing solutions
Engaging in argument from evidence
Obtaining, Evaluating, and communicating information

The following Disciplinary Core Idea is supported:
ESS3.C. Human impacts on Earth systems
LS4.D. Biodiversity and humans
ETS1.A. Defining and delimiting engineering problems
ETS1.B. Developing possible solutions
ETS1.C. Optimizing the design solution

Supports Performance Expectations:
K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.
K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2. Evaluate competing design solutions using a systematic prcoess to determine how well they meet the criteria and constraints of the problem.

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2. Design a solution to a complex real world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthethics, as well as possible social, cultural, and environmental impacts.

SUPPORT FOR COMMON CORE STATE STANDARDS

W.1. Text Types and Purposes
W.2. Text Types and Purposes
W.8. Research to Build and Present Knowledge
SL.1. Comprehension and Collaboration
SL.4. Presentation of Knowledge and Ideas
SL.5. Presentation of Knowledge and Ideas